Coronal Heating by Nanoflares and Alfvén Waves, Predicting Observational Features (Master Thesis)

Alfvén waves are good candidates to heat and maintain the solar corona to the observed few million degrees (Alfvén 1947, Hollweg 1982). Another appealing candidate is the nanoflare heating, in which energy is released through many small reconnection events (Parker 1988; Priest et al. 2002). Distinguishing the observational features of each is an extremely difficult task. In this thesis we address this problem by setting up two coronal loop models using the CIP-MOCCT scheme (Evans & Hawley 1988, Yabe & Aoki 1991), each one heated by one of the two mechanisms. The first model is a 1-D HD code in which numerous heating events are input randomly (uniformly) along the loop (nanoflares). The second model is a 1.5-D MHD code in which, in addition to nanoflares, Alfvén waves are also created, following Moriyasu et al. 2004, by sub-photospheric motions at both footpoints. The waves convert non-linearly to slow and fast modes that dissipate their energy through shocks. Both models reach a uniform state that satisfies the RTV scaling law. Alfvén waves are found to produce a more dynamical corona with strong slow and fast shocks. The transition region is pushed upward by magnetic pressure from the waves reaching heights of 10 Mm. On the other hand the uniformly distributed nanoflares have a smoothening effect permeating the corona with weak acoustic shocks. The heating events increase locally the temperature but thermal conduction is high enough to distribute efficiently the heating throughout the loop. The transition region is less dynamic and oscillates with periods close to the observed chromospheric 3 minute oscillation. We construct for both models the intensity flux distribution as would be observed with Hinode/XRT. The Alfvén wave intensity profile is more spiky due to the stronger shocks. Hence, the general picture of nanoflares, being ubiquitous, sporadic releases of energy is here closer to the Alfvén wave model than the own "Nanoflare" model. However, footpoint concentrated nanoflares can create more dynamic coronas (Taroyan et al 2006) and have a better observational support (Aschwanden 2001) but are left as future work.

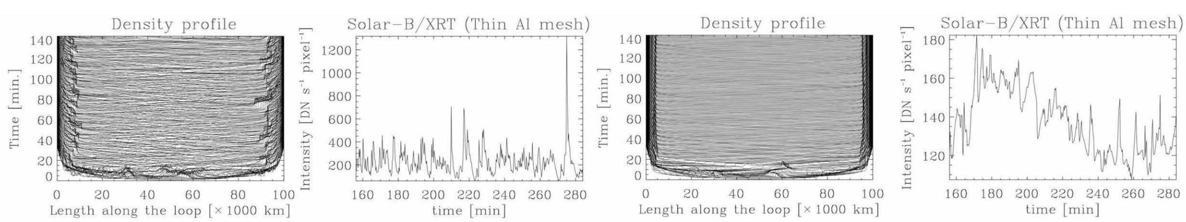

図: Density profiles along the loop and Intensity fluxes at the apex of the loop for Nanoflare models with (left two figures) and without (right two figures) Alfvén waves.

(Antolin Patrick 記)